



THE UNIVERSITY *of* EDINBURGH

## Edinburgh Research Explorer

### Evaluating technologies for children's learning

**Citation for published version:**

Manches, A 2018, Evaluating technologies for children's learning: The challenges, and steps to address them. in L Hamilton & J Ravenscroft (eds), *Building Research Design in Education*. 1 edn, Bloomsbury Academic, pp. 213-236. <<https://www.bloomsbury.com/uk/building-research-design-in-education-9781350019515/>>

**Link:**

[Link to publication record in Edinburgh Research Explorer](#)

**Document Version:**

Peer reviewed version

**Published In:**

Building Research Design in Education

**Publisher Rights Statement:**

This is an Accepted Manuscript of a book chapter published by Bloomsbury Academic in Building Research Design in Education on 14-06-2018, available online: <https://www.bloomsbury.com/uk/building-research-design-in-education-9781350019515/>.

**General rights**

Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

**Take down policy**

The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact [openaccess@ed.ac.uk](mailto:openaccess@ed.ac.uk) providing details, and we will remove access to the work immediately and investigate your claim.



## **Chapter 11 Evaluating technologies for children's learning: the challenges, and steps to address them**

Andrew Manches

### **Key Chapter Points**

- Current research approaches to evaluating learning for children's technology are problematic
- Consider how technology itself may be integral to our definitions of knowledge and learning
- Consider how many complex contextual factors shape interaction with technology

### **Introduction**

From doors and driers to maps and magazines, the world around children is increasingly digital, with more products being specifically designed for children. In trying to appeal to adults (purchasers of children's technologies), these technologies often make claims about their benefits, in particular their benefits for learning, such as their ability to provide immediate feedback, or simply to help engage children. Many 'learning technologies' explicitly target formal education, leading to a number of initiatives trying to integrate these resources into schools (e.g., John & Wheeler, 2012). Unfortunately, whilst the transformatory impact of technology is evident across other sectors, the impact in Education is less clear. For example, a recent OECD report (Peña-López, 2015) suggests that the heavy investment in school computers and classroom technology has not resulted in increases in pupils' performance (although this report has since been criticized (e.g., Berry, 2015)).

Claims about the learning benefits of technologies also extend to those marketed at parents, and increasingly to younger children. In fact, according to a 2012 report by the Joan Ganz Cooney Centre (2012), 58% of Educational apps were categorized for toddlers/preschools. More recently we have seen more hands-on digital technologies for children (e.g. Figure 1). These also tend to promote their educational benefits,

indeed, retailers such as Amazon have created a new market label: STEM (Science, Technology, Engineering, and Mathematics) toys with this pretext (i.e. they support learning in STEM areas). Yet, again there is limited evidence that such technologies really do benefit children's learning, despite their claims.



*Figure 11.1: Technologies designed to support learning (Image credits: Douglas Robertson Photography. ( <http://www.douglasinscotland.pwp.blueyonder.co.uk/> )*

Therefore, given the appeal of ‘learning technology’ in both home and school contexts, we are justified in asking: do technologies designed and promoted for children’s learning actually support children’s learning? This translates to more focused evaluation questions, typically adopting the form: does [name of technology] support learning?

This chapter emphasizes that epistemic questions such as those above are deeply problematic. First, it is not always clear how we are defining the technology. Devices come with many applications. Applications come with many activities. But perhaps, more significantly, such questions required others to be addressed first: what do we mean by ‘supporting learning’, or any variations, e.g. improve results, beneficial effects, etc. And even if we agree on what we mean by ‘learning’, what do we consider as rigorous evidence or be certain in the knowledge that it has been ‘supported/ improved/ increased/ enhanced/ enriched’ etc. Of course, questions about what constitutes ‘evidence of learning’ is pertinent across the field of educational research. However, this chapter proposes that there are unique implications when evaluating technology: both in how technology is repeatedly presented as a having a contextually-independent effect on learning, and also in its ontological relationship to what we mean by ‘learning’.

The contribution of this chapter is to problematize the goal of evaluating ‘learning technologies’ and the role of ontology and epistemology in the methodological process. The chapter aims to help the reader critically reflect upon core methodological challenges by drawing attention to two key issues: 1) the complexity of the context in which technologies are used and 2) the challenge of defining ‘learning’ relative to technology. This chapter does not advocate specific methods, as the value of each method will ultimately depend upon the questions being asked. Instead, the chapter proposes a methodological approach that recognises the two key issues discussed.

### **Why evaluate?**

How we evaluate children’s technologies will inevitably reflect what we intend to achieve (as well as more pragmatic factors such as time/budget). Often the intention

may be quite pragmatic: to inform a decision to acquire or use a particular technology. For example, parents may want to evaluate a particular app before sharing with their child, or a teacher may want to be informed about the value of a new technology such as 3D printers before integrating them into the classroom. Similarly, evaluation may be desired to develop guidance for others, from a head teacher developing a school-wide strategy to a government developing national policy. In previous work, for example, my colleagues and I have evaluated the evidence for a wide range of technologies in order to inform non-departmental public bodies (Manches, Phillips, Crook, Chowcat, & Sharples, 2010) and independent foundations (Luckin et al., 2012). In such reports, the need to provide an overarching picture of technologies for learning limits the ability to provide a more nuanced account of any particular example (although case studies are sometimes provided).

In contrast, the intention to evaluate may be driven by the research goal of increasing our knowledge of *how* a particular technology, or group of technologies, influences learning. Such work can inform theory which can then be drawn upon to guide individuals toward the most effective way to integrate particular technologies in their context. Some researchers adopt this approach to design technologies; they test and build theory through iterative developments of a particular design, hence the term ‘design-based’ research (Anderson & Shattuck, 2012b).

In reality, ‘informed decision’ or ‘theory-driven’ approaches to evaluation are less easy to separate: understanding how a particular technology influences learning can help inform decisions of whether to adopt the technology. Nevertheless, the key message is that we cannot consider how to evaluate technology independently of why we are evaluating. Understanding how a technology influences learning may be interesting but cumbersome to interpret for a practitioner wishing to make a quick purchase decision. Indeed, it is no surprise that many online evaluations offer simple scale ratings (e.g. Common Sense Media’s app reviews), such as a score of 1 to 5 for terms including ‘Educational value’. In contrast, research, particularly doctoral research, will seek to provide a more substantial in-depth understanding of how technology influences learning. For example, in my own doctorate (Manches, 2010), I evaluated the potential of tangible technology (digitally augmented objects) for early

learning by examining how physically manipulating objects (e.g. wooden cubes) influences children's strategies when solving number problems. My research compared how children solved problems using physical materials compared to specifically chosen other materials such as squares on paper, or squares children could manipulate on a touch-screen Tablet.

### **Limitations of current evaluation work**

A quick search on the internet demonstrates the wide, possibly overwhelming, amount of research published on different learning technologies. As a crude example, at the time of writing, searching “virtual reality” and “education” reveals over 389,000 hits on Google Scholar, although only a selection of these will be empirical studies evaluating particular designs. Unfortunately, despite the wealth of empirical evaluations, most focus on qualities other than learning. As an indication of this, a key text in this field: “Evaluating Children’s Interactive Products” (Read & Markopoulos, 2014) provides a comprehensive summary of different methods for evaluating more tractable qualities such as usability, likeability or accessibility, but offers more limited guidance on how to assess learning benefits (Manches, Horton, & Yarosh, 2010).

For evaluation work that does focus on learning, an important consideration is the relationship between the evaluator and the product design. It is understandable that an individual will likely be more content with findings demonstrating the positive impact of their work/product, and this potential for bias may unintentionally influence their methodological approach in at least two key ways. Firstly, in the way in which they define and measure learning and secondly, in their influence of the context in which the technology is evaluated. This chapter proposes that these two aspects are key to considering any evaluation of learning technology for children, and are subsequently examined in more depth.

## **What we mean by learning with respect to technology**

If we are interested in how technology influences learning, it is important to define what we mean by learning. Unfortunately, this is not always clearly communicated in research studies, although, the impression given by many authors, either explicitly (e.g. Jong et al., 1998) or by implication, is that learning is about acquiring knowledge. However, not only does this introduce new questions about what we mean by ‘knowledge’ (See Chapter 1), but is likely to sit uncomfortably with more constructionist pedagogical stances arguing that knowledge is constructed rather than transmitted. This definition of learning also frames knowledge as something rather static and independent of the environment – something independent that can be ‘acquired’. Such a definition can be contrasted to those working in more recent theoretical paradigms that consider knowledge as distributed across a culturally constituted world (e.g. books), not just within brains. These more recent theoretical paradigms reflect an epistemological shift by arguing that knowledge is something intrinsically bound to a social, cultural and physical context, rather than something that can be extracted, stored and retrieved. For example, in my own work, children’s knowledge of mathematics is situated in the tools we provide (e.g. blocks or number lines), cultural practices (e.g. counting together) and the physical actions involving in ‘doing mathematics’ (e.g. pointing when counting), rather than some decontextualized abstractions laying within children’s heads. The significance of this epistemological shift in thinking is the need to consider the social, cultural and physical context in which children demonstrate their thinking.

### **Activity 11.1**

*A possible activity to help think about the significance of this paradigm shift is to really observe how we judge what children ‘know’. Is it just through the symbols they write on page? What else do we look at? The language they use? Their drawings? How they move their hands when they talk? How engaged they seem?*

Different perspectives of knowledge have required changes in how we define learning.

Hutchins offers the following definition of learning: “*adaptive reorganization in a complex system*” (Hutchins, 1995, p.289). By using the term ‘*adaptive*’, Hutchins’ definition highlights how the value of what is learnt will ultimately depend upon the child’s unique world. Learning how to work efficiently with international peers may be highly adaptive to one child’s world; learning how to de-contaminate water may reflect another’s. Even within a shared culture, perceptions of value may vary depending on what knowledge/skills are considered valuable. For example, individuals may disagree about the importance of knowing how to spell as we move to an environment where nearly all formal writing is digital and can be autocorrected.

Whether ‘acquiring’ or ‘re-organising’, definitions of learning share a common feature: learning is about change, and implies some form of positive judgement of that change. When evaluating technologies, we are interested in the role of a particular design in this change: how, and possibly how much, any changes in the child’s interaction with the world can be attributed to the design. In trying to understand the role of technology in how children change their thinking/interaction with the environment, we can focus on the *process* of their interaction with the technology or the *outcome* of this interaction.

## **Process V Outcome**

Methods focusing on the learning process seek to describe what happens when children use technology: Do children appear interested (eye gaze)? Do they stay ‘on task’? Do they express themselves in novel ways (e.g. create animated stories?). Are they interacting with peers, and if so, how does the technology feature in their interaction? Do they engage with adults with the technology? Furthermore, we can examine how children change their interaction within tasks; for example, do they change strategy? Do they start answering more questions ‘correctly’? Do they explore a range of possibilities or focus on one particular approach? A useful activity is to consider what you would consider evidence that a child seems to be learning. What is



notably different from a child who appears *not* to be learning?

An important question is how we can judge whether the way children interact is indicative of learning. Although some measures are predictive of improved outcome measures (e.g. time on task), they tell us little about how the particular technology influences learning. To help address this challenge we can draw upon work describing the value of particular types of interactions. One example is offered by the Decoding Learning report (Luckin et al., 2012), which was commissioned to evaluate evidence for the potential of learning technologies. In order to examine the way technologies have been designed to support learning, the report presents eight types of ‘learning themes’. These eight themes are themselves synthesized from a list of 17 forms of learning acts (forms of interaction), co- developed by one of the authors in previous work (Crook, Harrison, & Tomas, 2011). Rather than advocate a particular theory of learning, these eight themes offer a language to reflect upon how technology can influence different interactions considered important in learning.

The eight learning acts are:

- Learning from experts
- Learning with others
- Learning through making
- Learning through exploring
- Learning through inquiry
- Learning through practicing
- Learning from assessment
- Learning in and across settings

The methodological significance of providing frames to describe the process of learning is that they offer a language to examine and analyze children’s interaction with technology. For example, how does technology mediate children’s interaction across settings (e.g. online learning journals)? How is technology generating

opportunities to learn from assessment (e.g. annotating videos)? Or, how does technology present new ways for children to learn from experts (e.g. through virtual simulations)?

### **Activity 11.2**

*An interesting activity is to consider how some everyday technologies, such as cameras, video conferencing or search engines, might help some of these learning interactions.*

### **Outcome: transfer**

Focusing on process can therefore tell us much about *how* technology influences interactions that we believe are significant for learning. However, many evaluations seek to know the result, or outcome, of using technology. They want to identify how children can apply what they have learnt in one context (using technology) to another context: *transfer*.

Unfortunately, children find transfer notoriously difficult (Bransford & Schwartz, 1999), where performance degrades over time and for tasks that are less similar to the learning context ('far transfer tasks'). This is methodologically significant because it requires us to critically reflect on when and how we measure the outcome of children's learning with technology. We can predict much greater 'effects' will be found if measuring soon after a task (although there is interesting research suggesting that there are benefits from having a sleep before testing (Drosopoulos, Wagner, & Born, 2005)), and for a task that is similar to the learning context. For example, if evaluating a mathematics app where children practise sums, the greatest benefits may be found if measuring soon afterwards on a test involving similar sums – how well children can 'replicate' what they have learnt.

According to Bransford & Schwartz (1999), a problem of many formal assessments is that they focus more on how efficient learners are at replicating what they have learnt. They contrast this with more interpretative aspects of learning that are best demonstrated in more novel contexts. The authors argue that there are relative merits of these two dimensions of learning and transfer, and their work presents their own thinking of how each can be engendered and assessed.

The key methodological implication for evaluating learning technologies is to consider the relationship between the learning task and the task assessing the outcome of this learning experience. It is also important to consider the relationship between the context to which you wish to generalize. For example, when assessing what children have learnt using a mathematics app, there is the context of using the app, the context of assessing what children have learnt (e.g. a paper and pencil test carried out alone at a desk) and the everyday world context that this learning is meant to support (e.g. helping calculate change in a shop). The expression we use to describe the relationship between the assessment task and the everyday context is *ecological validity*.

Therefore, it is important to consider the relationship between the context of the learning experience, the assessment task and the everyday situations which you think the learning experience can support. ‘Near transfer’ tasks may detect greater effects of the learning activity (because they are similar) but may be a poor indicator of how this learning transfers to everyday contexts. But herein raises a fundamental issue: to what extent do we consider technology itself as part of our everyday contexts?

### **Activity 11.3**

*A point of reflection is considering the proportion of tasks where you do or do not use digital technology, for example, communicating with people, writing letters, calculating bills, having fun. How does this proportion vary across people, and across ages? How might this proportion change in the future?*

### **Effects with, effects of, technology**

In 1990, Salomon (1990) provided a useful lens to reflect on the role of technology between contexts by distinguishing between the “*cognitive effects with computers, whereby one's performance is redefined and upgraded during intellectual partnership with the computer, and effects of computers, whereby such partnership leaves durable and generalizable cognitive residues later on*”. Assessing what children have learnt with a particular technology by using an assessment task without this technology assumes that children have developed knowledge that is technology-independent (‘cognitive residue’). However, recent epistemological paradigms

discussed previously argue that we need to re-consider this relationship between the external (things outside our heads) and internal (things inside our heads). More recent theoretical perspectives argue that cognition is externalized (we use the environment to support thinking), embodied (our thinking is inseparably linked to our prior experiences with the environment) and even extended (we should consider our environment as part of our cognitive system). For example, our knowledge of where our friends are, and details for how to contact them, will often depend on our everyday technologies such as mobiles. This example illustrates our ‘intellectual partnership with the computer’, a partnership that has arguably continued to grow since Salomon wrote his paper.

It is therefore important to consider differences between the context of any learning activity and the context of where this learning is evaluated, particularly in relation to the role of digital technology. During my final degree exams, I wrote, re-wrote and consequently learnt using my computer. But I was not allowed my computer in the exams. Practical issues aside (e.g. my ability to write non-stop for two hours), the assessment task using pencil and paper dramatically changed the nature of the task. And significantly, it changed the nature of the task to one I have not encountered ever since those exams –despite the importance of writing for my career.

When children are learning with technology, we have to be very careful about testing the ‘cognitive residue’. Instead, we may want to assess how they develop an intellectual partnership with technology that they can draw upon in future tasks. Learning experiences using and creating multimedia (e.g. showing their understanding of a science concept by creating an animation) may help children later express themselves through these media, in a similar way to how learning from reading/writing may support how they later express themselves through this particular (non-digital) technology. When evaluating children’s learning with technology we should always critically reflect upon our assumptions that learning can be demonstrated through other media, e.g., writing, drawing. The most significant benefit of children’s experience using a mathematics app may actually be their capacity to use touch-screen devices to solve future numerical problems.

## Context of learning

The previous section discussed the need to consider how the context of learning may differ from the context in which such learning is evaluated. This presents the challenge of unpacking what we mean by ‘different contexts’. What factors are important.

### Activity 11.4

*For example, as you read this chapter, what factors influence what meaning you draw, beyond the quality (or otherwise!) of the writing itself? Are you reading from a book or digital device? Alone or with company? In the morning or evening? Are you tired or hungry? What prompted you to read this chapter (personal choice?)? To what extent do you feel these different factors do, or do not, make a difference to what you are ‘learning’?*

The difficulties of examining learning in context due to the complexity of interrelated factors, have long been recognised (O'Donnell, 2004). However, possibly reflecting the more unique ability of digital technology to provide both an artefact and designed responses (interactive activities), the influential role of multiple factors is often downplayed. This is most evident in questions and methodological approaches that isolate the effect of technology, for example, “Do Tablets support learning? Or “Will Augmented Reality transform education?”. Such questions often fail to recognise the dynamic and complex context in which technologies are used. This is useful advice for any researcher reflecting upon their choice of research question. Unfortunately, this does raise a challenge: how do we frame and communicate the context in which a technology is used, given such complexity.

Factors that influence how a technology is adopted into a particular context often echo those that determine *if* the technology is adopted in the first place. In the final report for BECTA’s Harnessing Technology strategy (non- departmental public body funded by the UK’s Department for Education) colleagues and I identified 8 significant factors (Table 1) influencing the successful introduction of new technologies.

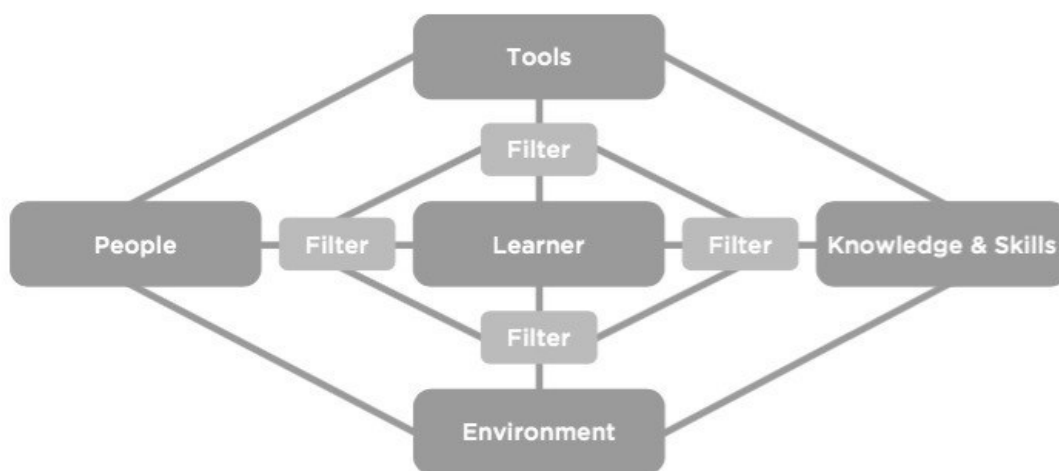
**Table 11.1: Factors mediating integration of technology into educational practice**

<i>Factor</i>	<i>Description</i>
Home – School setting	The relationship between informal (e.g. home, museum) and formal settings (e.g. classroom)
Learning Spaces	The design of the space in which technologies may be used
Curriculum Flexibility	The extent to which the curriculum can be adapted to accommodate different tools / ideas
Assessment Culture	The requirements to obtain and utilise specific assessment information
Leadership	The role of leadership at different levels, within and beyond individual institutions
Teacher skills / confidence	Individual teacher’s own skills, attitudes and experiences toward technology
Reliability	The reliability of the technology when used
Appropriation of available tools	The extent to which available tools can be adapted to teaching context

These factors are evident in much work examining the challenges of introducing digital technology into the classroom. For example, in the Decoding Learning report (Luckin et al., 2012), which was commissioned to evaluate evidence for the potential of learning technologies, consideration was given to the key contextual factors influencing particular digital interventions, such as who was there to support learners.

To frame the contextual factors, the report drew upon prior research of one of the authors: Rose Luckin (2008). Figure 2 illustrates how the success of any intervention will ultimately depend upon a range of resources: people, tools, environment and knowledge and skills, and hence we need to consider how a particular context filters access to these resources. For example, the way that the curriculum filters the types of knowledge and skills that learners are exposed to, as well as the available materials, spaces and human support. A key message from the Decoding Learning report is that innovative digital innovations are less about new technologies and more about novel, and well considered, ways of using existing digital tools (e.g. using a digital camera for personal inquiry across contexts). The significance of this work for those researching in this field is the need to consider the validity of isolating certain variables within a complex system.

**Figure 11.2: Learning Context (Based on Luckin’s Ecology of Resources)**

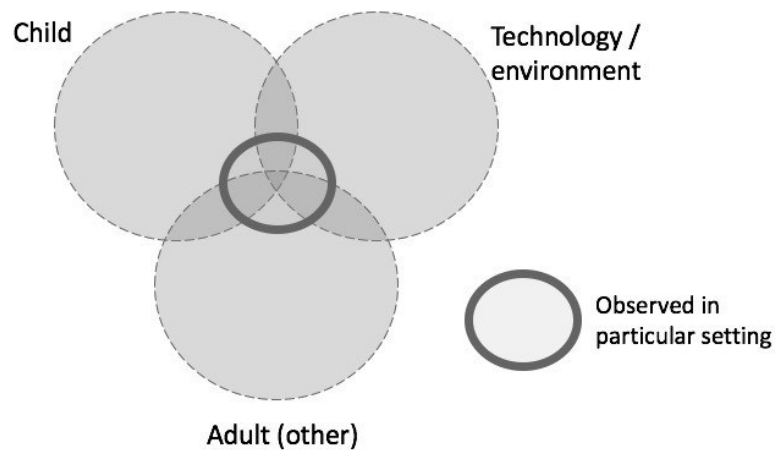


## **Factors shaping interaction with technology**

Research has shown therefore that the way children interact with technology (or whether they interact at all) greatly depends upon a complex range of factors that, according to Plowman (2016) interweave and dynamically unfold within a particular ‘context’. So, from a methodological point of view, this presents a challenge – to what extent should a research project try to disentangle the complex web of factors influencing children’s interaction with technology? Should we, for example, examine how the digital design evokes parents’ own childhood recollections, which may ultimately influence the way they support children? Should an evaluation consider internet speed? What about children’s prior relevant experiences? Predictably, the answer depends on the research focus and questions being asked. To gain deeper insight into how a particular technology mediates children’s interaction, it may be important to explore a wide range of possible influences, possibly as a detailed case study. Whilst such depth of exploration may not be feasible if working with multiple children, it will still be valuable to frame the key factors influencing children’s interactions in order to plan, interpret and communicate any evaluation. Doing so offers the reader a better understanding of the particular conditions of an evaluation, and how these may translate across different conditions, for example, by reflecting on whether their own context offers the same adult or technical support.

Figure 3, illustrates three key observable actors in a particular interaction, factors that are articulated in dominant social learning theories (e.g., Vygotsky, 1978). Whilst an adult may not necessarily be present during children’s interaction with technology, they will likely have played a key role before and afterwards in accessing, curating and setting up technologies. It is also possible to consider how the design of a particular technology often incorporates the adults’ role in the digital feedback given to children (e.g. drawing attention to a particular action; stating whether an answer is correct). The main implication of Figure 3 for researchers is to consider the range of factors that will influence how children interact and potentially learn when using technology. Simply measuring what children know before or after interacting with technology may conceal the influence of the factors. Instead, it is possible to observe the dynamic interplay between these factors.





**Figure 11.3: Considering factors influencing children’s interaction with technology**

### **Observing context of interaction**

Interaction is multimodal so it is possible to focus on one or several modes such as speech, intonation, gesture, or physical or on-screen actions. In some of our previous research, for example, Colleagues and I have focused on the dynamics between children’s (aged 0-3 years) and parents’ speech, gesture and actions when interacting with Tablet devices (Figure 4). In this research, we were seeking to better understand how these devices influence parent-child interaction. As well as observing children’s interaction with parents (in situ and later from video recordings), we interviewed parents (and older children) and collected questionnaires.



**Figure 11.4: Dynamic interplay between children's and adults' modes of interaction using technology**

Trying to capture interaction in real-time is challenging, therefore, it is possible to benefit from a range of recording devices (e.g. camera; microphone) for later inspection. However, it is important to remember how observing or recording individuals is likely to influence their behavior (although sometimes it is easier to place recording devices so they are easier to forget about, notwithstanding important ethical considerations). There are also the significant limitations of timing – only being able to capture what occurs at the time of data collection, or alternatively set up a particular interaction which is necessarily unnatural. In some of her earlier work, Plowman (2015) addressed this challenge by asking parents to take pictures/videos of children's interaction with technology at the time it was occurring.

### **Considering factors beyond the observable context**

The interaction between a child, adult (other) and technology (and environment) will depend upon a wider range of factors that may not be observable at one particular time. This chapter argues that it is possible to frame the complex range of factors influencing children's interaction with technology in terms of the three actors in a particular interactional context: children, adults (other) and technology (environment). For example, assessment procedures are significant, but these are mediated by the teachers' (or students', for older children) interpretation of these. Similarly, finance

(e.g. device cost) is important but this can be considered as a factor sharing what equipment (and teacher development) is available at a particular time. Table 2 presents examples of some influential factors.

**Table 11.2: Wider factors influencing children’s interaction with technology**

Overarching factor	Possible significant factors shaping interaction
Technology and surrounding environment	Range of ways to physical interact with the device (e.g. touchscreen, titling, moving, linking to other objects via Bluetooth)
	Range of different applications possible on the device (e.g. different apps)
	Technology set up (and pack away) time (e.g. installing app, charging devices)
	Reliability of technology (e.g. power; internet, errors)
	Physical space to move the technology (inside/outside, at tables/on floors)
	Influence of other tools (e.g. access to paper alongside technology)
	Experience of technology – notably the ‘novelty effect’ of new designs
	Knowledge/Understanding of the core relevant ideas
	Experience of content (e.g. recognizing characters)
	Physical dexterity (e.g. ability to double click, trace accurately)
	Perceptions of identity in relation to the activity (e.g. gender)

	Adults' own digital experiences (e.g. their use of social media, their childhood memories)
	Adult's Confidence (link to experiences and other factors such as training)
	Beliefs/Values in technology (e.g. do they see technology has having a generally positive role; do they see technology as core to the future)
	Beliefs/Values in learning area (i.e. do they think the learning area is important; how does the area fit with the curriculum)
	Perceptions of support (e.g. head teachers; parents)
	Relationships with peers (e.g. pride in using technology innovatively)
	Technical support available (both generally and immediately to problem fix in class)

**Table 11.2** is not a comprehensive list of factors, but serves to exemplify factors that may (or may not) shape any given context. As discussed in the previous section, these contextual factors are not simply factors influencing what knowledge children ‘acquire’ but rather an intrinsic part of what we consider knowledge. For example, children’s physical, social and emotional interaction with a tablet may be core elements of what is means to ‘read’. Therefore, it is important for any research to consider their epistemological position when collecting data on children’s interaction with technology. Are factors such as adult support or battery charging problems seen as mitigating variables, as ‘noise’? Or are they considered an important part of the rich, dynamic fabric of activity?

It is possible to explore factors such as those in Table 2 through a number of methods such as interviews, surveys, document analysis, or observing other tasks. Some factors (e.g. internet access) may be more amenable to examination than others (e.g. cultural attitudes). However, whether or not these factors are explored in a study, we should at least be mindful of their possible role. For example, in one project investigating the potential impact of a new tool for multimodal assessment (assessing portfolios including media such as video) all was well until we learned (almost by accident) of a key challenge: teachers encountered significant issues trying to send large files to external markers give a small outline of the research. Whilst it could be said that this obstacle falls beyond the context of the children using the technology for learning, the finding was that this obstacle demotivated teachers who then developed negative attitudes towards the technology. At first, they discouraged children’s use, and ultimately prevented its use. Such an outcome does seem relevant when evaluating the potential of a technology to support children’s learning. In another study evaluating early learning apps for a major media company, we found significant differences in how children were accessing a particular set of screen-based learning games– via a Tablet, Laptop, or large interactive whiteboard in class. The devices varied substantially in the skills and experiences required to manipulate them, and how they mediated different forms of interaction with adults (e.g. mobile phones are not easy for groups to observe compared to classroom interactive whiteboards).

## Activity 11.5

*Consider any particular learning activity with technology and simply list the range of factors that may influence interaction. How does your list compare to another's?*

*Having written a list, then consider the relationship between your factors, for example, internet reliability and teacher's attitudes, or parental attitudes and children's experiences with different devices.*

## Conclusion

Evaluations and research into technology for learning often presents technology as having some intrinsic pedagogical value independent of the context in which it is used, resulting in 'technocentric' questions such as "*does [particular device/digital activity] support learning?*" The answer to such questions is: it depends. It depends on the role of many factors that fluidly shape children's interaction with that device/application/activity. And it depends on how you define and measure learning. If defining learning as how a child has adapted to complex system (everyday life), it is necessary to consider the role of those factors across diverse future scenarios, and notably whether the technology under examination plays its own part within those scenarios.

Evaluating if and how technology supports learning is therefore challenging, where this chapter presents two fundamental questions that should be considered when interpreting research in this area, namely:

- How is learning being defined? What is the relationship between the context of the learning experience, the assessment task and the range of everyday settings that learning is being generalized to? How does the increasing integration of technology in our lives change these everyday settings?
- What factors played a role when children interacted with the technology? What factors are reported and how significant could they have been? What, potentially significant, factors are not reported? What is the relationship between contextual factors when children interacted with technology, when they were assessed, and the everyday scenarios this learning is intended to benefit?

Raising these questions draws attention to the difficulty in addressing seemingly simple questions presented in the form: Does [*name of technology*] support learning? These questions help explain why evidence is often mixed on the benefits of a particular technology or group of technologies (different contexts/definitions of learning), the dangers of designing studies to confirm what you believe/want to show (select specific contexts/learning tasks) and the significant challenge facing anyone wishing to conduct research in this area.

Unfortunately, as with much educational commentary, it is often easier to critique than propose guidelines of good practice. Whilst, this chapter aims to highlight why there is much lack of agreement over what constitutes good practice, the following methodological guidelines are offered:

- Be explicit in how you define knowledge and learning

Is learning something you can identify in terms of particular types of interactions, or is it defined by change that can be quantified in some way (including simple ‘more’ or ‘less’ statements). Is knowledge considered independent or dependent upon social, cultural and physical dimensions of interaction? Does technology itself play a role in what it means to know in your area of focus? To what extent is your definition of learning shared (including by the ‘learner’)?

- Be clear and honest about the contextual factors shaping the intervention using technology

As stated by Shattuck: “*The researcher is careful to document the time, commitment and contingencies that are involved in the creation and implementation of the intervention. These are documented so that readers of the research can judge for themselves the possibility of achieving similar – or even better results – from the use of this intervention in their own contexts*” (Anderson & Shattuck, 2012a)

- Reflect upon the relationship of the (task and) context between the learning experience, when this is assessed, and the everyday context to which learning

will be generalized

Is the assessment task close to (near transfer) the learning experience, and if so, is this to intentionally capture more replicative rather than interpretative knowledge? What other evidence is there that performance in the assessment task generalizes to everyday contexts (ecological validity)?

- Be clear and honest about the potential for your own bias

Is there value in you finding a particular outcome, and if so, how have you guarded against your unwitting influence on the study design to ‘discover’ this outcome? Could you have introduced supportive factors in the learning experiences that may not be there later (e.g. technical support, greater adult to child ratios)?

This chapter argues that these questions are important to consider at some level, whatever your reasons for evaluating technology for children’s learning: whether you are trying to analyze learning processes in depth, or simply informing a judgement on whether to purchase the next interesting design.

### **Activity 11.6**

I referred previously to my own research evaluating the potential of tangible technology to support early learning. Ten years after this research, I span out a company from the University developing a set of Tangible blocks to support early numeracy: Numbuko.



*Numbuko Blocks ([www.numbuko.com](http://www.numbuko.com))*

Numbuko are intelligent blocks that change colour according to the specific number



attached in a row, in order to help children to explore and talk about number patterns.

- How would you evaluate Numbuko?
- How would your research differ depending on whether you are a researcher or practitioner?
- As the designer of Numbuko, what would I need to do to minimize my own potential bias if evaluating Numbuko myself?
- Drawing on the key points of this chapter, what methodological issues can you identify if trying to evaluate Numbuko by carrying out a controlled comparison with another early maths product?

### **Recommended reading**

- Light, D. (2008). Evaluating Educational Technology Interventions: How do we know it's working. Paper presented at the Quest, Bangalore, India. \

Whilst focused mainly on the US, this paper shares over 21 years of experience from the Centre for Children and Technology group, demonstrated clear understanding of the challenges of evaluating technology and some of their practical suggestions for how to resolve.

- Luckin, R., Bligh, B., Manches, A., Ainsworth, S., Crook, C., & Noss, R. (2012). Decoding learning: The proof, promise and potential of digital education.

I draw upon this report several times in this chapter. The report has been described as a key text for those interested in evaluating learning, and is written in accessible language. The report is long but I would certainly recommend the introduction and discussion chapters.

- Plowman, L. (2015) Studying children's everyday uses of technology in the family home. *Interacting with Computers*. 27 (1) 36-46.

This paper offers an expert understanding of the challenges of evaluating technology in children's homes and ways to address these challenges

- Rodríguez, P., Nussbaum, M., & Dombrovskaya, L. (2012). ICT for education: a conceptual framework for the sustainable adoption of technology-enhanced learning environments in schools. *Technology, Pedagogy and Education*, 21(3), 291-315.

This work focuses on successfully integrating technology into schools and builds on research in 6 countries.

### **Advanced Reading**

- Radich, J. "Technology and interactive media as tools in early childhood programs serving children from birth through age 8." *Every Child* 19.4 (2013): 18.

This is the joint position statement on young children technology from the National Association for the Education of Young Children (NAEYC) and the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College. It is an important text, if only for the fact that many practitioners may draw upon this for guidance. It is interesting to compare the current NAEYC position with previous statements, where more recent work recognises the role of technology for younger children (<5).

- McReynolds, E., Hubbard, S., Lau, T., Saraf, A., Cakmak, M., & Roesner, F. (2017). Toys that Listen: A Study of Parents, Children, and Internet-Connected Toys. Paper presented at the CHI 2017, Denver, CO, USA.

Whilst it is beyond the remit of this paper to examine the potential risks of technology (including the need to explain why many scare stories can be ignored due to lack of empirical support), a more recent issue that I believe is significant with respect to new technologies, is the issue of toys that capture children's personal data. This conference

paper highlights this concern, using examples from recent connected toys.

- Bransford, J. D., & Schwartz, D. L. (1999). Rethinking transfer: A simple proposal with multiple implications *Review of Research in Education*, 24 1999 (Vol. 24, pp. 61-100). Washington: American Educational Research Association.

This paper is referenced in this chapter and is recommended for those interested in developing their understanding of the complexity of assessing learning, and the issue of transfer. The paper proposes a new approach to assessment that considers how well we can apply our learning in unfamiliar contexts.

- Manches, A. (2013). Emerging Technologies for Young Children: Evaluating the Learning Benefits of New Forms of Interaction. *Handbook of Design in Educational Technology*, 37, p.425-445.

This book chapter provides more theoretical depth around evaluating more recent technologies that offer more direct, hands-on, interaction.

## **Weblinks**

<http://children-and-technology.ed.ac.uk> -

This will take you to the home page of the Children and Technology group in the School of Education, University of Edinburgh and provides some more information about some of the early technology projects we have worked/are working on, including work evaluating apps for children.

<https://www.common sense media.org>

This is a good example of a review website providing summary reviews of a range of children's media including apps. It is a good reference to critically reflect on some of the arguments put forward in this paper.

<http://www.joanganzcooneycenter.org>

This is the home page of the Joan Ganz Cooney Center who have an international reputation for their work on young children and technology.

<https://llk.media.mit.edu>

This is the homepage of the Lifelong Kindergarten group at Massachusetts Institute of Technology (MIT). As well as the researchers behind the well-known programming environment for children – Scratch (and Scratch Jnr), they have produced many leading projects exploring the potential of playful technology.

